COL 786 - Advanced Functional Brain Imaging - Assignment 1

Due Date:
7:00PM, Sunday, 9th February, 2025
Max Marks: 100

Notes:

- The objective of this assignment is to familiarize you to the FSL tool (specifically the fslview or fsleyes sub-tools) used for processing fMRI data. Students who wish to use SPM instead of FSL may choose to do so at their own risk.

- To learn to identify the four lobes and cerebellum of the brain using the anatomical markers discussed in the CourseRA course on "Medical Neurosience" by Leonard E. White, Duke University. at coursera.org – Module 3, Neuroanatomy, Surface Anatomy of the Human CNS. Specifically, you may watch the following videos:

    - Lateral Surface of the Brain
    - Medial Surface of the Brain
    - Finding the Central Sulcus
    - Ventral Surface of the Brain
    - Building a Digital Brain (Fingers to Gyri)

- To learn to use the atlas tool in the FSLview/FSLeyes (or SPM).

- The assignment is to be done individually

- **Write-up:** You are required to submit your write up in *pdf* format on *Gradescope*.

- For each of the lobe, write down a few sentences about what key markers that you identified in the images provided in order to identify the four lobes and cerebellum.

- Also include the screen shots of images on your FSLview/FSLeyes screen in your write-up suitably labelled to identify the landmarks. You may use any tool to label your images. One of such *OpenSource* online tools is here

- Make sure all the images in the write up are of **high resolution.**
    spreadsheet

- For doubts send an email to Rahul Garg

1. **Lobe Identification - (35 points)** You are provided with two images, first, a T1 weighted brain image (`T1_weighted_image.nii.gz`) and second a T2 weighted image (`T2_weighted_image.nii.gz`). Your objective is to open these images in fslview/fsleyes and:

   - Identify the four lobes (and cerebellum) in both the images
   - Locate the key distinguishing landmarks for the four lobes

   You will find both the images in the drive location:

   Submit your write up describing the distinguishing landmarks of the four lobes and cerebellum, along with suitably labelled images of your screenshots. Your screenshot should have all the three views (sagittal, coronal and transverse) and mark the landmarks and lobes on all the three views.

2. **Using Atlas to identify brain regions (35 points)** Load the standard MNI brain atlas template (MNI_152) in fslview/fsleyes and use the atlas tools to identify the following brain regions.

   (a) Broca's area (left)

   (b) Wernicke's area (left)

   (c) Fusiform Face Area (FFA) (left)

   (d) Amygdala (right)

   (e) Hippocampus (right)

   (f) Thalamus (bilateral)

   Use the superimposed probability maps from the atlas to identify the above regions. Please also indicate the atlas used for this purpose. Include the screenshot in the write up where the regions are identified. Be sure to ensure that the MNI coordinates in your screenshot are visible. Your screenshots should have all the three views (sagittal, coronal and transverse).

3. **Plot Time Series (30 points)** You have been provided with the registered fMRI data on the drive link. File name (`A00010893_filtered_func_reg.nii.gz`)

   The fMRI file is taken from *NKI-RS dataset* TR=645ms, checkerboard protocol (block design with 20 seconds of fixation and 20 seconds of flashing checkerboard, three repetitions). See the following link for the data description and the protocol:

   - mri_protocol
   - CheckboardParadigm.txt

   The data provided to you had already been pre-processed and registered to standard MNI atlas. You have to perform the following tasks:

   (a) Locate the **Thalamus** and plot the time series of Thalamus using FSLview (or fsleyes) ($\hat{T}$ to plot the timeseries in fslview. Try to find an activated voxel in the Thalamus and plot its timeseries. By activated voxel, we mean a voxel that responds to the visual checkerboard stimuli).

   (b) Locate the **Primary Visual Cortex** and plot the time series of one voxel in the visual cortex which you think may be active in response to the flashing checkerboard. Plot the time series of this voxel. Also report the MNI coordinates of this voxel. The time series of this voxel should resemble the idealized BOLD signal (HRF convolved with experimental paradigm of flashing checkerboard).

   Report the plots and observations for both the part in the write up.